BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: CSM Electrical Source/ Distribution Bus Configurations During Manned Block II Flight - Case 320

DATE: March 14, 1968

FROM: W. H. Hodge

ABSTRACT

The configuration of CSM electrical source-to-distribution bus connections does not remain constant throughout a mission. Events such as Service Propulsion System burns and CM/SM separation dictate changes in ways energy sources are used and/or the way the energy is distributed. This memorandum describes these changes during manned Block II flights. The changes are also illustrated by a series of configuration charts.

BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: CSM Electrical Source/ Distribution Bus Configurations During Manned Block II Flights - Case 320

DATE: March 14, 1968

FROM: W. H. Hodge

MEMORANDUM FOR FILE

The configuration of CSM electrical source-to-distribution bus connections does not remain constant throughout a mission. Events such as Service Propulsion System burns and Command Module/Service Module separation dictate changes in energy sources and/or distribution of that energy. This memorandum describes these changes during manned Block II CSM flights. The attached figures illustrate the various configurations assumed during the mission. In addition, Table 1 is a brief description of the types of loads powered by each bus.

LAUNCH

From approximately one minute prior to lift-off until just after earth orbit insertion (EOI), the configuration is as follows: (Figure 1)

*	FUEL CELL #1	→ MAIN DC BUS A
*	FUEL CELL #2	→ MAIN DC BUSES A & B
*	FUEL CELL #3	→ MAIN DC BUS B
	ENTRY BATTERY A	→ BATTERY BUS A
	ENTRY BATTERY B	→ BATTERY BUS B
	ENTRY BATTERY C	→ EDS BUS #2 (LAUNCH VEHICLE INSTRUMENT UNIT)
	BATTERY BUS A	→ MAIN DC BUS A
	BATTERY BUS B	→ MAIN DC BUS B
	BATTERY BUSES A & B	→ BATTERY RELAY BUS
	MAIN DC BUS A	→ INVERTER #1
	MAIN DC BUS B	→ INVERTER #2
	MAIN DC BUSES A & B	→ FLIGHT BUS
	MAIN DC BUSES A & B	→ FLIGHT & POST LANDING BUS
	MAIN DC BUS B	→ **NON-ESSENTIAL BUSES #1&#2
*	INVERTER #1	→ AC BUS #1
*	INVERTER #2	→ AC BUS #2

*Mirror image connections are possible.

**Can also be powered by Main DC Bus A.

DRIFTING FLIGHT

After EOI, the configuration is changed to that indicated in Figure 2 by disconnecting Battery Buses A & B from Main DC Buses A & B and Battery C from EDS Bus #2. At this time, power requirements would allow a switch to single inverter operation. By crew preference, however, the dual inverter operation will probably be maintained for reasons such as improved load balancing and increased reliability.

PEAK POWER REQUIREMENTS

For Service Propulsion System burns, the electrical system is configured to provide for the peak power demands of the SPS gimbal actuators. This peak power congiguration is the same as that used during launch except that Entry Battery C is not connected to any bus (Figure 1). Immediately following SPS burns, the configuration is returned to that used in drifting flight.

DEORBIT & DESCENT

Just before a reentry SPS burn, the electrical system is once more placed in the peak power configuration (Figure 1) with one addition - Entry Battery C is then connected to Main DC Buses A & B. This configuration is maintained until CM/SM separation. At separation the fuel cells and SM buses are eliminated leaving the Main DC Buses powered only by Batteries A, B, & C (Figure 3). These three rechargeable, 40 amp-hour capacity batteries thus serve three principal functions--additional energy supply for peak power requirements, reserve source in case of fuel cell malfunction, and sole energy source for entry and post-landing periods when the fuel cells are no longer available.

During descent on the main parachutes, Battery Buses A & B and Entry Battery C are connected to the Flight and Post-Landing Bus. Following these connections and completion of the RCS purge operation, the Batteries are disconnected from the Main DC Buses A & B, leaving them without an energy source. After touchdown and stabilization, all connections with the Main DC Buses A & B are broken and Battery C is disconnected from the Flight and Post-Landing Bus to be held in reserve until depletion of Batteries A and B. The Battery Relay Bus is also disconnected from Battery Buses A & B at that time. The configuration shown in Figure 4 is maintained until crew egress, at which time the entry batteries are all completely disconnected.

MISCELLANEOUS

In addition to the above mentioned electrical sources, there are two pyrotechnic circuit batteries in the CM. These batteries are independent of the rest of the electrical system (except that they can be backed-up by the entry batteries). These pyrotechnic batteries are connected to the pyro buses only when the spacecraft pyro devices are to be actuated. These periods are:

(1) Launch; from approximately thirty minutes before lift-off until just after earth orbit insertion;

(2) Rendezvous and docking;

(3) S-IVB/LM separation;

(4) CSM/LM separation;

(5) From CM/SM separation until just after touchdown and stabilization.

The configurations mentioned in this memorandum only apply to nominal operation. The Electrical Power System is flexible; it can be used in alternate configurations (e.g., single inverter, single or dual fuel cells) to provide for a case of equipment failure, necessity to conserve cryogenics, or other non-nominal situations.

2031-WHH-mao

W. H. Hodge

BUS	LOAD TYPES
MAIN DC A & B	HEATERS TRANSDUCERS VALVES ESSENTIAL INSTRUMENTATION LM TRANSLUNAR COAST LOADS
BATTERY A & B	SEQUENTIAL SYSTEM LOGIC SPS GIMBAL CONTROL
AC 1 & 2	ROTARY EQUIPMENT LIGHTING
BATTERY RELAY	FUEL CELL AND INVERTER CONTROL CIRCUITS
FLIGHT	COMMUNICATION EQUIPMENT USED ONLY DURING FLIGHT
FLIGHT & POST-LANDING	AUDIO EQUIPMENT LIGHTING POSTLANDING BEACON, VENT VALVE, ETC.
NON-ESSENTIAL 1 & 2	FLIGHT QUAL RECORDER NON-ESSENTIAL INSTRUMENTATION
SM DC A & B	SPS GIMBAL MOTORS CRYO TANK VACUUM ION PUMPS SM JETTISON CONTROLLERS

THE LIST OF LOAD TYPES IS NOT INTENDED TO BE COMPREHENSIVE.
SOURCE-BUS AND BUS-BUS CONNECTIONS ARE SHOWN ON THE ACCOMPANYING DIAGRAMS.

TABLE 1: DISTRIBUTION BUS LOAD TYPES

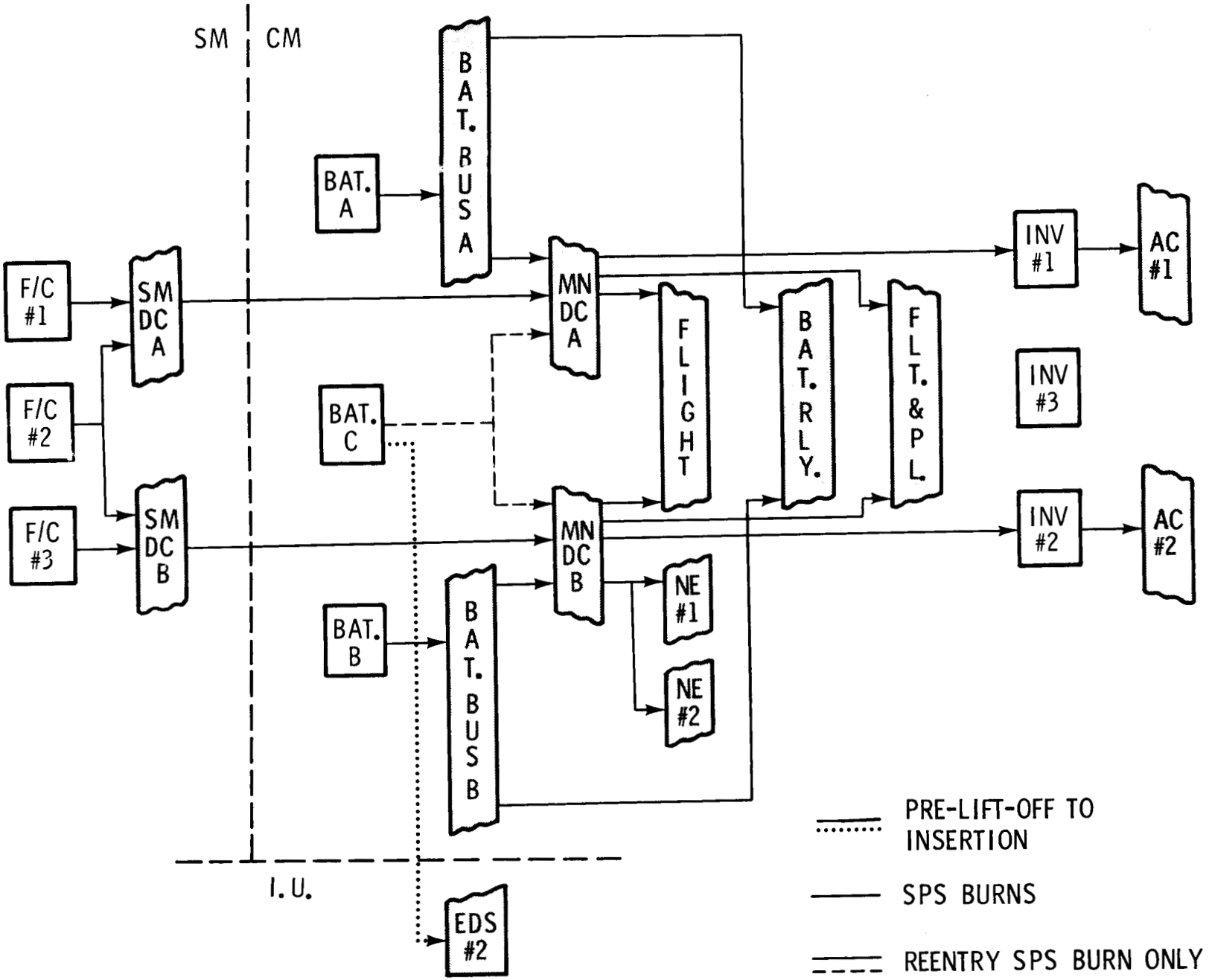

FIGURE 1 - PEAK POWER PERIODS

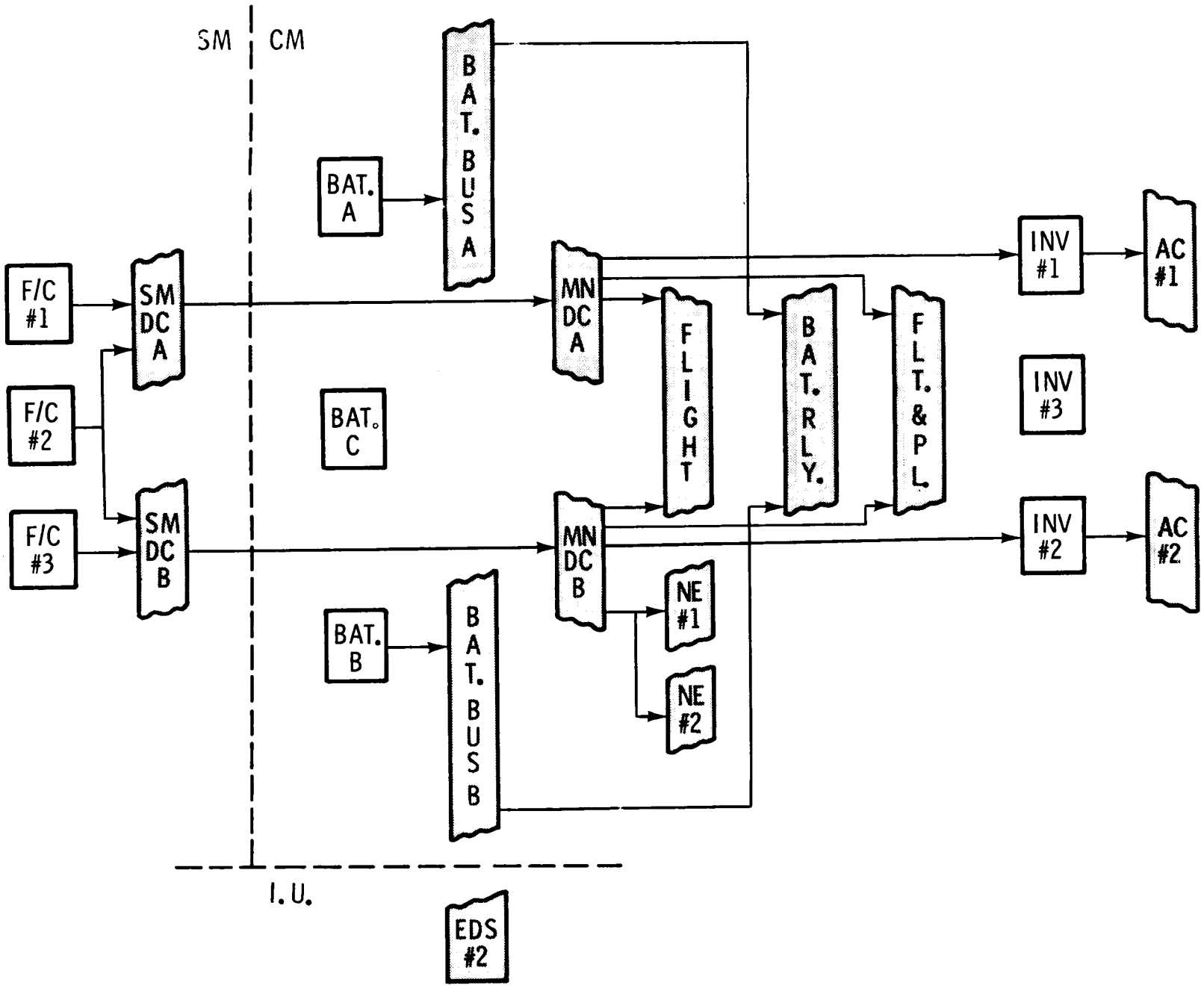

FIGURE 2 - DRIFTING FLIGHT

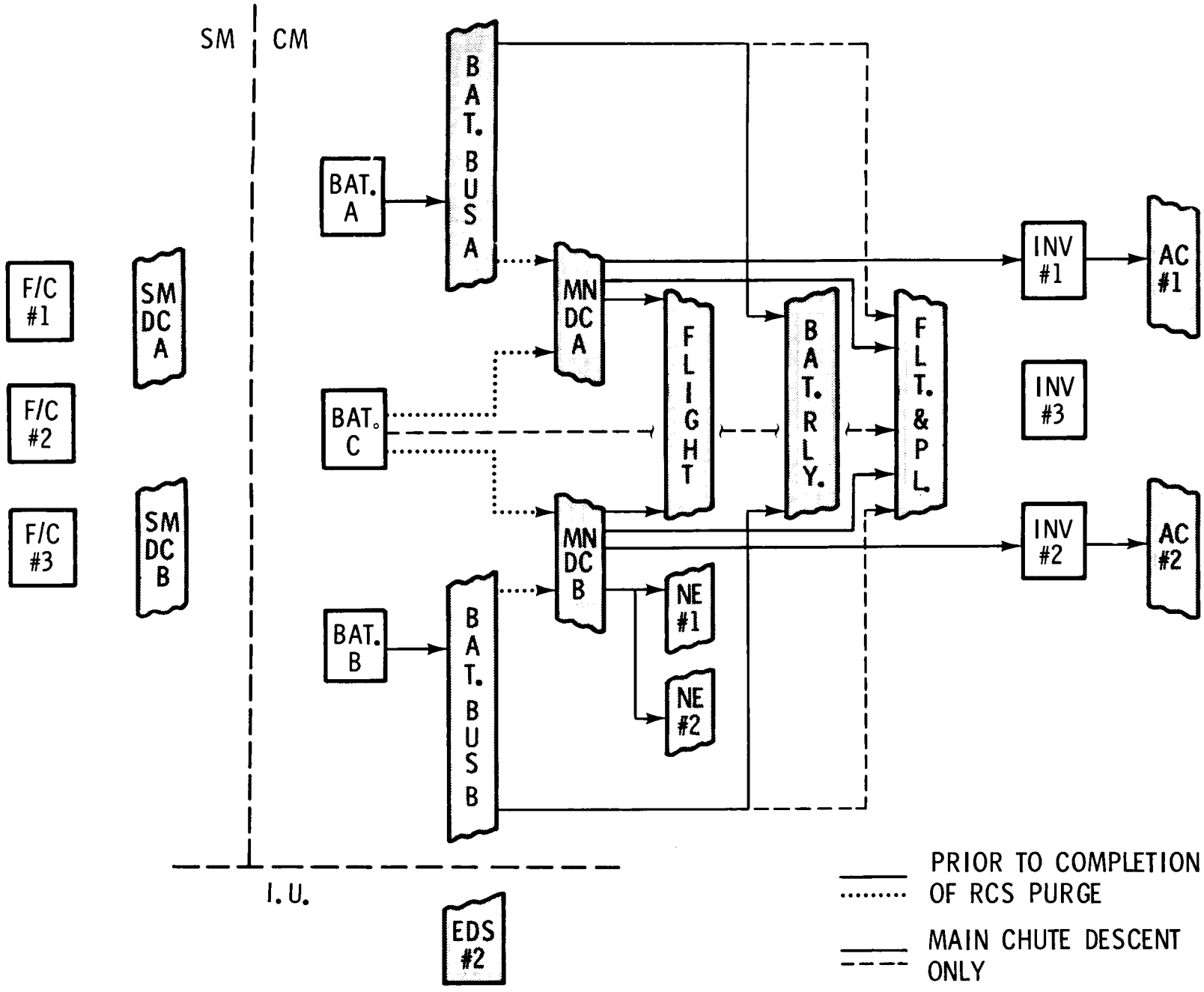

FIGURE 3 - CM-SM SEPARATION TO TOUCHDOWN

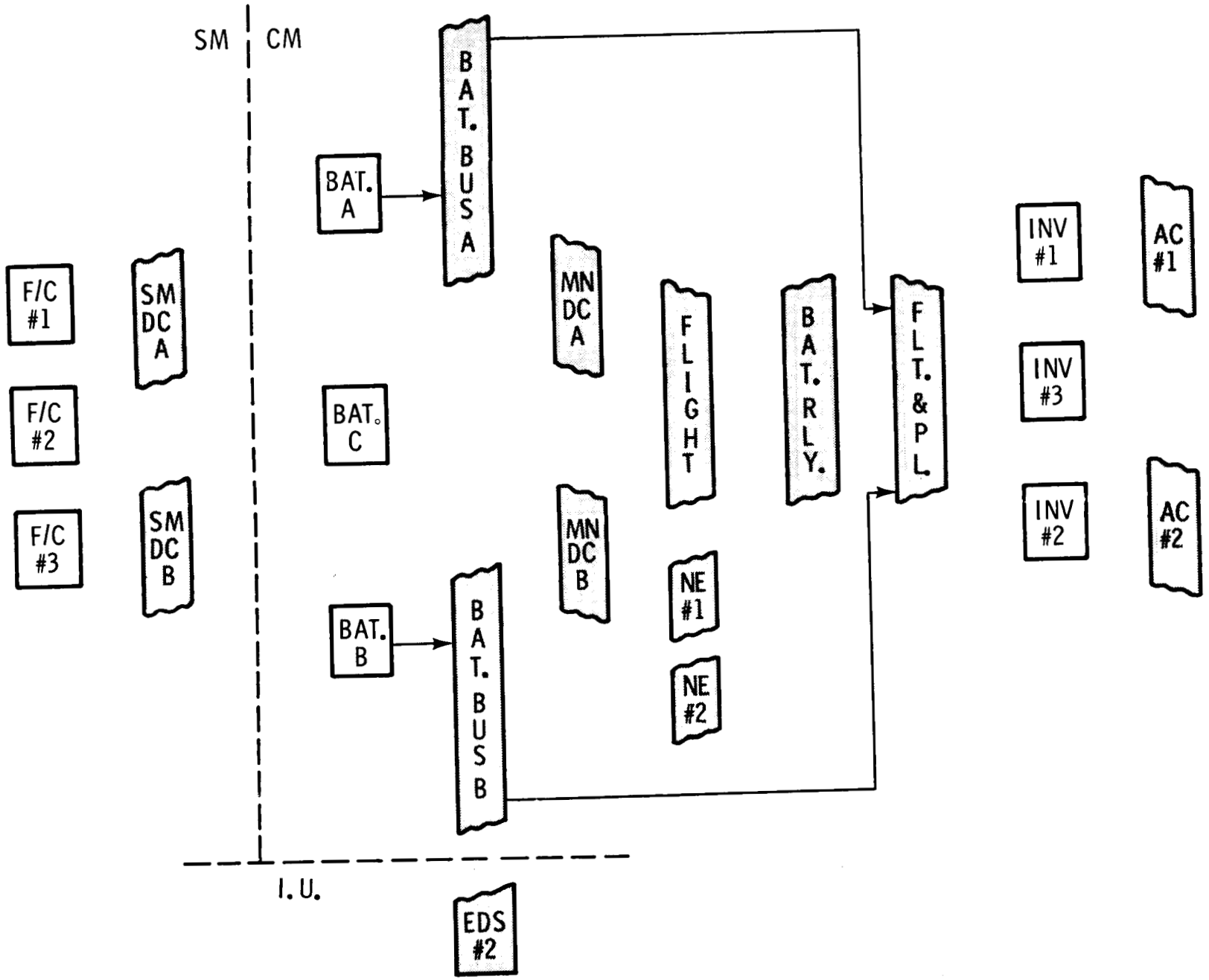

FIGURE 4 - POST-LANDING

BELLCOMM, INC.

Subject: CSM Electrical Source/ Distribution Bus Configurations During Manned Block II Flights - Case 320

From: W. H. Hodge

DISTRIBUTION LIST

NASA Headquarters

Messrs. L. E. Day - MAT
C. C. Gay - MAT
G. H. Hage - MA-A
J. K. Holcomb - MAO
T. A. Keegan - MA-2
C. W. McGuire - MY
J. B. Skaggs - MAP
W. C. Schneider - MA
G. C. White, Jr. - MAR

Manned Spacecraft Center

Messrs. G. S. Abbey - PA
A. Cohen - PD
G. D. Griffin- FC
S. C. Jones - PD4
K. S. Kleinknecht - PA
T. R. Loe - FC

Bellcomm, Inc.

Messrs. G. M. Anderson
A. P. Boysen, Jr.
D. R. Hagner
W. C. Hittinger
B. T. Howard
R. K. McFarland
J. Z. Menard
V. S. Mummert
T. L. Powers
P. E. Reynolds
I. M. Ross
R. L. Wagner

Department 2031
Department 1023
Central Files
Library